PAR 245
30 Sep 66

SUBJECT: BPE High-Magnification Lens Sets

TASK/PROBLEM

1. Design, fabricate and test prototype optical systems to extend the Briefing Print Enlarger (prototype) PAR 243A, upper limit magnification range from 60X to 140X - 160X.

DISCUSSION

2. The optical design of the following were completed during September:

a. Two objective lenses, and

b. One condenser set.

3. For the 95X to 153X requirement (Lens Set "H"), a seven-piece, N-type lens with f/2.2 relative aperture was designed to meet Specification 469-334. The condenser is a three-piece design having only glass elements with spherical surfaces.

4. In the design of the 60X to 97X lens (Lens Set "G"), the optical designers encountered excessive oblique spherical aberration. Four different arrangements of elements were explored with the design optimization programs and evaluated according to the computed ray-trace data.

a. The first arrangement was a scaled-down version of the seven-element design of the 40X to 60X lens for the BPE (Lens "F") with the relative aperture adjusted from f/2.8 to f/2.6. Design performance was just under the specification over most of the required field.

b. Two eight-element lenses were tried. These were acceptable everywhere in the field except in the range of 16° to 18° semi-field angle.

c. In an attempt to improve the performance at 18°, a nine-element lens was designed. This design was better everywhere except in the 16° to 18° range.

The failure of these lenses to meet the specified performance at 90% energy level at 18° semi-field angle is due to sagittal oblique spherical aberration which cannot be adequately corrected without losing image quality at smaller field angles.

5. The best optical design among those explored for the 60X to 97X range, judged upon the ray-trace prediction of performance and its manufacturability, is one of the eight-element designs. For field angles 16° to 18°, it is expected to deliver 80% of the energy into a specified circle rather than the design goal of 90%. The design achieves the design goals for the majority of the angular field and the compromise of image quality at the extreme edges of the field appears relatively minor. At 60X, the area in the specified rectangular 20 x 24 print beyond 16° is about 3.6% of the total picture area. At magnifications above 66X, the field angle required to cover a 20 x 24 print is 16° or less. The best means to judge the image-quality in such a case is examination of prints exposed with a sample lens. It is planned to proceed with design and fabrication of the completed eight-element optical design to allow such testing.

PLANNED ACTIVITY

6. During the next month, it is planned to:

a. Release the optical designs for the objective lenses for mount design and sample fabrication.

b. Complete the optical design of the second condenser system.

c. Release the focussing assemblies for the two objective lenses for fabrication.